Title: Modeling of an Islanded Operation Controller for Power System Study
Name of the Contributor: Biswarup Mukherjee and Prof. Luigi Vanfretti
Institution/Organization: IIT Bombay, FOSSEE; ALSETLab, RPI, USA.
Email: bismuk.ece@gmail.com , vanfrl@rpi.edu

Abstract:

An islanded operation controller is used in a power distribution network to correct the frequency deviation when the distribution grid is islanded from the transmission grid. The controller is modelled using the Modelica language and it is tested in a power network shown in Figure 1, built using the components from the OpenIPSL library.
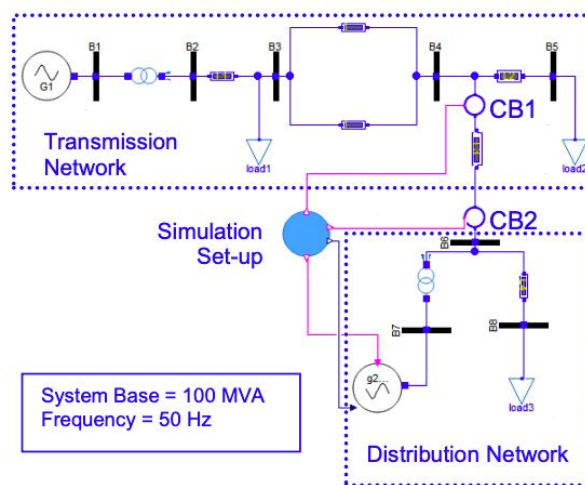
Figure 1:The OpenCPS benchmark power network model using components from the OpenIPSL

The controller uses a PI function and modeled using a centralized control architecture that receives data from phasor measurement units (PMUs), thereby complementing existing generator control systems instead of replacing the existing ones. The controller is activated when the distribution side is islanded from the main transmission grid and it retains a zero frequency deviation of the distribution network. The distribution network generator model shown in Figure 2. A simple logic to activate the controller is implemented within the simulation set-up.

To run this simulation in your favorite Modelica tool, e.g. Open Modelica, follow the steps below:

1. Open the file "`IslandedOperationControl.mo`".
2. Upload the `OpenIPSL` library package. Otherwise use the `OpenIPSL` library included within this package "`IslandedOperationControl.mo`".
3. The package "`Network`" contains two power system models. The generator model used in the distribution network of "`Network_DL`" includes the islanded controller. For "`Network_CD`" the islanded operation controller remains disabled".
4. Go to the "`Simulation`" tab of your tool, and simulate both the models under the package "`Network`".
5. Compare the plots of the distribution network frequency for both the power system models.
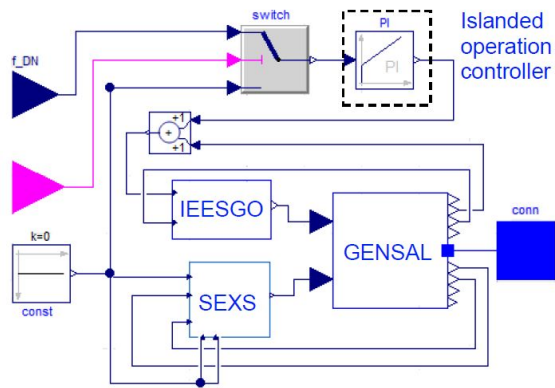
Figure 2: Modelica implementation of the distribution network generator model

Description of the simulation:

Both the power system models inside the package "`Network`" were simulated for 70 seconds. Figure 3 shows the distribution network frequency deviation for both the power system models. After the circuit breaker islands the distribution network from the transmission network, the islanded operation controller is activated to maintain zero frequency deviation in the distribution grid. It can be seen from the red trace that when the controller remains active there is no frequency deviation; however, the blue trace shows that there will be a frequency deviation in the distribution network, when the controller is disabled.

Conclusion:

The supplementary islanded frequency controller can be used in a distribution grid to retain a frequency deviation of zero when islanding occurs.
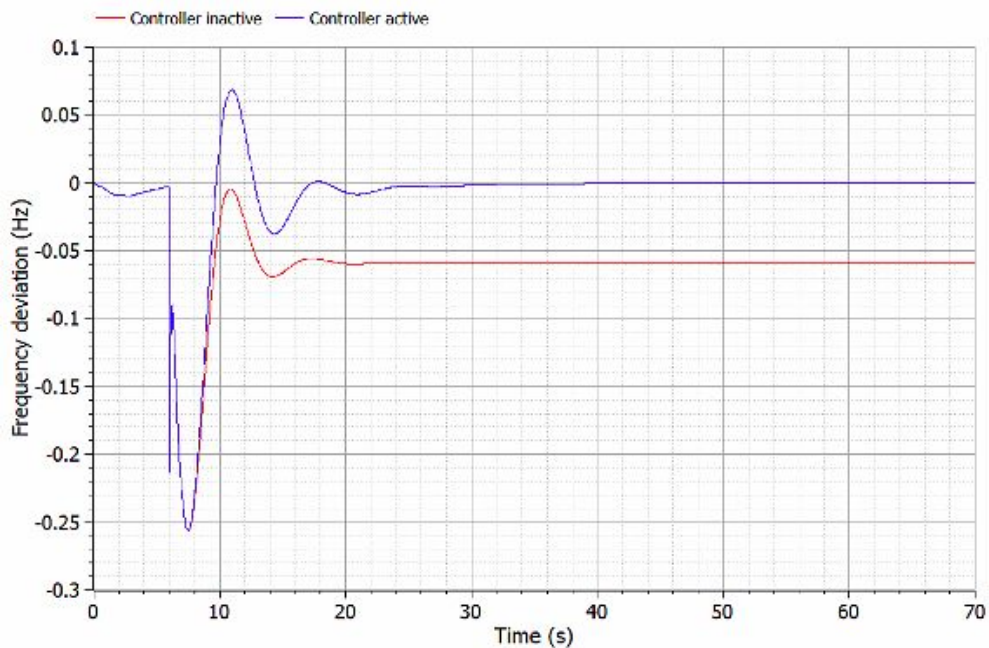

Figure 2: Distribution network frequency deviation

References:

1. B. Mukherjee, L. Vanfretti, "Modeling of PMU-Based Islanded Operation Controls for Power Distribution Network using Modelica", American Modelica Conference 2018, Cambridge, MA, USA. DOI: 10.3384/ecp18154112